COLLABORATION TOOLS TO SUPPORT INFORMED PUBLIC ENGAGEMENT

GIRLING, CYNTHIA L.
University of British Columbia, cgirling@sala.ubc.ca

BOOTH, KELLOGG S.
University of British Columbia, ksbooth@cs.ubc.ca

KELLETT, RONALD W.
University of British Columbia, rkellett@sala.ubc.ca

MAHYAR, NARGES
University of California at San Diego, nmahyar@ucsd.edu

BURKE, KELLY J.
University of British Columbia, kelly.burke@ubc.ca

KRAHN, ALIX
University of British Columbia, alix.krahn@gmail.com

1 ABSTRACT

New public engagement methods are increasingly geared toward discourse, collaboration, and interaction that emphasize: providing understandable yet credible information targeted to the audience; integrating data and visualizations; employing experiential and interactive modes of engagement; and collaborative design. Active engagement through hands-on workshops increases the diversity of viewpoints and groups participating and can improve learning and buy-in for final solutions. Digital planning support tools enable concurrent "live" consideration of multivariate and interdependent information, including marrying geo-spatial information with social processes and empirical metrics. But many such tools intended to meet these needs are expert-intensive, forcing the public to be passive consumers. A new generation of digital tools puts users in the driver seat and enables interaction and collaboration. We report on a user study that tested one such user-driven system, designed to engage the public in collaborative urban design exercises, against a traditional paper-based workspace. University students from various disciplines served as surrogates for the public in an exercise of designing a walkable neighborhood center. Pre- and post-surveys, group debriefing interviews, and video-taping provided detailed data about group processes, interactions and experiences. We found that the single workspace for co-design, clearly defined work task, evidence-based feedback and tactile nature of both workspaces contributed to active engagement and collaboration. The digital system provided deeper information with better visualizations, and enabled a different collaborative process, but both workspaces were rated as engaging by participants, which may suggest that both paper and digital engagement tools have a valuable place in public engagement workshops.

1.1 Keywords

public engagement; visualization; digital engagement tools, co-design

2 INTRODUCTION

The problems and therefore solutions to attain more sustainable, resilient forms of urban development are complex and so are the voices or stakeholders who must be consulted in public processes. Diverse voices enable consideration of issues of environment, society, equity, and economy, however, each different voice will come with different knowledge areas, values, and modes of learning, thus finding effective methods of working and communicating is a challenge (Wheeler 2013). Responding to these complex problems and the necessary diversity of stakeholders, new public engagement methods are increasingly geared toward discourse, collaboration, and interaction that emphasize: providing understandable yet credible information targeted to the audience; integrating data and visualizations of information; employing experiential and interactive modes to engage people; employing social and peer learning (Sheppard, 2012; Moser, 2010; Holden 2008; Davis, 2008).

The increased complexity of urban planning and design, which must respond to complex social and environmental issues, necessitates that professionals utilize sophisticated computational models and analytics. However, this can create a knowledge gap between professionals and lay people and makes it far more difficult to engage lay people in planning and decision-making. As well, many such tools are expert-intensive, or operated by experts, leaving public participants to be passive consumers of information (Girling, 2017). In an effort to bridge this knowledge gap, digital tools are increasingly used to facilitate such collaborative engagement in planning (Girling, 2017, Senbel, 2011; Salter 2009).

This study was conducted in this context of evaluating processes and tools to engage diverse stakeholders in urban design decision-making. It focused on employing hands-on interactive modes of engagement, providing rich information in understandable formats combined with visualization of both spatial and numeric information. It compared two different co-design workspaces and evaluated the workspaces for: providing understandable, timely information; integrated data and visualizations; and most importantly for encouraging collaboration, engagement and learning.

2.1 Background

Innes and Booher (2004) proposed that 21st Century public engagement in planning must be genuinely collaborative, inclusive of diverse stakeholders, and include multi-dimensional communication. Their rationale is that such collaborative processes can help to solve complex and contentious problems and concurrently build social capital whereas one-way public engagement has failed. Others similarly propose that contemporary collaborative planning and urban design should be accountable, responsive, and forward looking (Healey, 1997; Daniels, 1996). To achieve these aspirations, planning processes increasingly utilize collaboration, discourse, face-to-face interaction, and problem-solving amongst diverse stakeholders including governments, the public, and special interest groups (Innes, 2004; NCI, 2004; Daniels, 1996). Collaboration generally involves stakeholders working together to solve a problem using decision-making processes in which “trust and knowledge are generated and circulated, to provide a foundation of social and intellectual capital upon which collaboration can build” (Healey, 1997, p. 247).

A very diverse array of engagement techniques are used in planning practice, including opinion surveys, information dispersal (i.e. social media), open houses, interactive web sites, workshops, and design charrettes (Lennertz, 2006). We focus on hands-on design-oriented workshops intended to engender the principles of collaboration, discourse, and engagement. Such workshops are typically targeted to smaller numbers of people (can fit in a room) and smaller scales of problems such as development sites or neighborhoods. Sanoff (2000) proposes that successful workshops are characterized by high levels of interaction amongst participants, working toward a common goal, and people learning from each other. Common characteristics of such workshops include: collaborative; tacit knowledge creation through discourse, collective (or peer) learning, and creative experimentation; split-second, intuitive knowledge about what is right that is typically developed through hands-on experimentation; an environment that supports (encourages) creativity; horizontal organization (all are equal); and improvisation (Roggema, 2014). Several authors have observed that active engagement through hands-on workshops and design charrettes increases the diversity of viewpoints and groups participating (Lennertz, 2006; Brody, 2003) and enables discourse that improves peer learning and buy-in for final solutions (Holden, 2008; Innes, 2004).

Active engagement through hands-on workshops and design charrettes increases the diversity of viewpoints and groups participating (Lennertz, 2006; Brody, 2003) and enables discourse that improves peer learning and buy-in for final solutions (Hollander, 2012; Innes, 2004). Co-design is a term for collaborative public engagement workshops which focuses on interactive engagement around solving a

design challenge. The term co-design refers to cooperative or collaborative design, participatory design, and user-centered design. It applies across many disciplines (Sanders, 2008; Sanoff, 2008; King, 1983). Originating in Scandinavia in the 1970s around industrial systems design (Sanders, 2008; Sanoff, 2008), co-design, as it has evolved in various design disciplines, refers to hands-on participatory modes of physical design that typically involve professionals as well as lay people (Sanoff, 2008; King, 1983; Cross, 1972). In North American design circles, the term design charrette has similar meanings and applications. Co-design applies Kolb's theory of active, experiential learning, "[t]he simple perception of experience is not sufficient for learning; something must be done with [knowledge]. Similarly, transformation alone cannot represent learning, for there must be something transformed, some state or experience that is being acted upon" (Kolb, 1984, p. 42). In other words, active or experiential learning is more effective than passive modes of knowledge transfer. Similarly, peer-to-peer learning in collaborative processes is more effective in active versus passive situations (Daniels, 1996). Innes (1998) proposed that information will influence policy decisions and public understandings if it is meaningfully discussed to the point of becoming "shared knowledge." Where people are making decisions or plans together and concurrently discussing the consequences of such decisions, greater acceptance will occur (Daniels, 1996).

Providing the right information at the right time in understandable formats is equally important in public engagement processes (Al-Kodmany, 2001). What information to provide in a public engagement process and in what formats, how, and at what times in the process impacts the effectiveness of public engagement (Brody, 2003). Bringing relevant information to the process in diverse formats is deemed important for reaching people of different backgrounds or with different learning styles (Daniels, 1996; Hollander, 2012). Whether information provided is comprehensive or narrowly targeted, whether it is given as 'fact' or open to discourse, and whether it is transparent vs. opaque (black box) all can influence stakeholder buy-in, empowerment and process outcomes (Innes, 1998; Hanna, 2000). Innes (1998) proposed that information must be of different kinds, including objective, science-based information, experiential information, and values-based information. The formats that information is presented in should be varied, including textual, verbal, numeric, graphic, and photographic so that diverse people can meaningfully engage with complex and information-rich discussions and decisions (Al-Kodmany, 2001).

Current theory holds that processes and tools that encourage and enable dialogue and interaction can assist with more effective public engagement (Senbel, 2011; Innes, 2004) and with communicating information. Furthermore, employing multiple channels (or formats) of information helps to reach diverse people in a process (Daniels, 1996; Hollander, 2012). Hollander (2012, p. 350) stated, "Intelligent Participation [multiple channel information] offers a framework for reinserting…the people into the story, by rethinking and redesigning public processes to meet their diverse learning styles and their multiple intelligences, while improving dialogue and encouraging dialogue." Digital tools can provide multiple channels of information concurrently, such as 2D maps, 3D renderings, photos, video, and both verbal and numeric data. Digital tools enable concurrent "live" consideration of multivariate and complex interdependent information, including marrying geo-spatial information (what is where) with social processes and empirical metrics (Arciniegas, 2012; Talen, 2011; Snyder, 2003). However as digital tools become more sophisticated, they often require expert operators, distancing the information from public participants (Ben-Joseph, 2001). A class of recent digital tools is explicitly targeted to lay users. This new generation of tools puts users in the driver's seat and enables interaction and collaboration (van der Laan, 2013; Arciniegas, 2012; Salter, 2009; Ben-Joseph, 2001). They help lay people understand how changes made at the scale of a building might impact the neighborhood and how neighborhoods may affect larger urban systems such as transportation networks (Girling, 2017). They also connect spatial information to indicators of performance, which helps people to understand the impacts of their decisions.

Visualization of information is one of the common contemporary tools used to increase understanding. Visualization, according to Planning and Urban Design Standards, is "the process of taking abstract ideas or data and translating them into easily understood or interpreted images to enhance planning, urban design and decision-making processes" (American Planning Association, 2006, p. 543) or, the act of interpreting information in visual terms. While it very commonly refers to realistic three-dimensional images of land or cityscapes (Kwartler, 2008), it increasingly also includes charts or diagrams of numerical or conceptual information. Contemporary modes of visualization in planning and design include systems that integrate 2D spatial (map-based) information and 3D visualizations with verbal and numeric data. Newer modalities for conveying information include serious games and virtual reality (Gordon, 2011). Digital systems enable "live" interconnected information and immediate feedback. Planners are increasingly using

digital visualizations to allow real-time alternatives exploration accompanied by just-in-time performance metrics (van der Laan, 2013; Sheppard, 2012; Kaliski, 2006). These systems can communicate complex urban design concepts through clear, accessible information. In participatory or collaborative planning processes these can help inform diverse stakeholder groups, establish a common language, foster community dialog (van der Laan, 2013; Senbel, 2011; Al Kodmany, 2000; Ben-Joseph, 2001), and enable social learning (Holden, 2008).

Paper-based, hand-made methods of representation (paper and hand) still predominate in design charrettes and hands-on workshops. While these paper and hand tools provide a tangible, experiential element and often allow multiple "hands" to contribute to design solutions, they also privilege consideration of the visual qualities of places over consideration of more complex or abstract information. This means that paper and hand methods could make it difficult to conduct rigorous evaluation in a timely manner (Girling, 2006). Some authors have discovered bias with regard to what information is shared with participants, who is invited to participate (Sorkin, 2006, Bond, 2007), and "editing" of which information is presented in which formats (Hollander, 2012). For example, Grant (2006, page 184) accuses some design charrette facilitators of presenting "slick graphics, romantic watercolours, and celebrity designers" to woo the public. In other words, pictures and graphics are often provided with intent to convince the public the proposed solutions are good solutions as opposed to offering up a range of divergent solutions, equally represented and compared with appropriate evaluative measures (Girling, 2006).

Digital tools on the other hand can help lay people understand how their decisions may impact the neighborhood and larger urban systems such as transportation networks (Arciniegas, 2012; Talen, 2011; Al-Kodmany, 2001). "While at one time it took several meetings to enable the public to make decisions, today feedback occurs instantaneously, enabling the same group of people to test alternatives and make informed decisions within a single meeting" (Kwartler, 2008, p 13.). Digital tools are increasingly being introduced into design charrettes and public engagement workshops to bring more diverse information into the conversation in a way that is accessible to diverse participants and in some cases to provide better analytical capabilities (Gordon, 2011; Lennertz, 2006). This study evaluated one such digital collaboration workspace, called UD Co-Spaces (Mahyar, 2016) (digital) against a comparable paper-based (paper) workspace. Our goal was to evaluate the tools and workspaces for (a) fostering engagement and collaboration in the co-creation of urban designs, (b) enabling participants to connect sustainability metrics to urban form, (c) making information tangible for a range of stakeholders, and (d) fostering discourse and learning.

3 METHODS

We focused the study on a particular type of design task, which is common in many public engagement workshops. We asked stakeholders, represented by student participants, to design an infill neighborhood center within a hypothetical existing single family neighborhood in the suburbs. Posed as a scenario, it assumed that the city in question (also hypothetical) had already been through a planning process and as a result had re-zoned the site of the design task to higher density mixed use development along a main street with higher density housing on adjacent parcels of land (zoning was colour-coded on a map). The scenario proposed that by adding higher density housing and commercial services, the walkablility of the neighborhood would be improved. The participants were charged with collaboratively designing the neighborhood center. Since a main goal of this type of design task is to explore alternative design options, the participants were encouraged to experiment, and create as many iterations of the neighborhood design as possible in the time permitted.

University students from various disciplines served as surrogates for the public. A total of 40 students (17 male, 23 female) participated in the study. Twenty-six were graduate students and 13 were undergraduates, with one non-student. Seven of the participants were graduate students in the Community and Regional Planning Program and six were students in the School of Architecture and Landscape Architecture. The ages of the participants ranged from 18 to 48 with a mean age of 25.6 years of age. Students were assigned to the groups according to their availability, and we distributed the planning and design students across all groups. Pre- and post-surveys, focus groups, and video-taping provided detailed data about group processes, interactions and experiences. Forty participants completed the pre- survey but only 37 completed the exit survey. There were a total of 8 focus group sessions with 4-5 participants in each session.

To engender conflicting values and goals, which are common in public engagement, the participants were randomly assigned roles: a long-time resident, a future resident, a developer, a senior citizen, and a renter in the neighborhood. Each stakeholder (role) was additionally assigned preferences that influenced their design choices and required consensus decision-making (Table 1).

Table 1. Participant roles.

Role color	*Role type*	*Preferences*
Pink	Long time resident	Pink: lived in this neighborhood for about 10 years; is opposed to high density development as it will change the character of the neighborhood; owns a home very near to the old school; would like to see the school site reserved for park uses; 4 storeys are overly high density.
Blue	Future resident	Blue: rents a basement apartment in a home within biking distance of this site; is looking to purchase an apartment or rowhouse in the near future; participated in the planning process, which designated this site for a neighborhood center; supports the principles of walkable neighborhoods; thinks a commercial area will make this area more walkable.
Yellow	Local developer	Yellow: a local developer who lives in this city but not in this neighborhood; Is interested in developing a 4 storey mixed use building (residential + commercial) on the site; believes the population of this neighborhood must be much higher to support commercial development.
Green	Senior citizen	Green: a recently retired, single senior citizen, who loves the neighborhood; owns a home about 10 minute walk away from the site; wants to live in the neighbourhood a long time; planning to downsize to an apartment near to shopping; 4 storeys are overly high density.
White	Renter	White: rents a room in a house within a 5 minute walk of the site; works part-time in the city; does not own a car/ does not want to; mildly interested in experiencing a public workshop.

Two workspaces: Half of the groups worked in a paper-based workspace while the other half worked in the digital workspace (Figure 1). The two workspaces included many similar elements— the map was at the same scale and appeared very similar; the same selection of buildings and parks, called “cases” was available (Table 2). In the paper workspace, the “cases” were provided on stiff paper pieces with a 2D plan view on one side and a 3D image on the other side, whereas they were displayed in a “case bar,” including the same selection of buildings and parks (as the paper workspace), along each of the four edges of the digital workspace so that each participant had equal access to this information (Figure 2). While the paper workspace included most important metrics for each case on the paper chips (numbers of dwellings and people, number of stories, and area of commercial space), participants had access to much more in-depth information on the digital environment. The digital workspace enabled “live” generation of both 2D and 3D urban design visualizations on the table and projected on a wall respectively. On individual iPads, each participant could also see and control a set of metrics that also live-updated (density, population, dwelling numbers, dwelling diversity, commercial floor areas, household energy use, and percentage trips that were walking trips) (Mahyar, 2016; Van der Laan, 2013).

Table 2. Digital and paper workspaces- information and media.

Information/media available	*Digital workspace*	*Paper workspace*
Map of study site at 1:1000	√ (participants could zoom)	√ (static)
2D (plan) view of “cases”	√ (on case bar)	√ (on paper chips)
3D view of “cases”	√ (on case bar + in 3D view)	√ (on paper chips)
Data about each “case”	√ Extensive	√ Very limited
Performance metrics about design solutions	√ Live-updated/controlled by participants	√ Prepared by researcher
Bird’s-eye view of design solution	√ (controlled by participants)	X (none)

The interactive multi-touch table system software (digital workspace) used in this project was developed explicitly to facilitate collaboration (including dialogue and interaction) around urban design tasks. The system was designed to be operated by untrained public workshop participants without direct operation by technicians. Participants received approximately two minutes of training on how to operate the table system before undertaking the collaborative design task.

Figure 1: Two workspaces. Left: one group working in the digital workspace showing the touch table 2D work surface, the iPad with metrics, and the 3D view projected on the wall. Right: One group working in the paper-based workspace with the paper pieces scattered about on the table. Photos by the authors.

Schedule of the workshops: Each workshop followed the same choreography as explained in Table 3. The five-minute lecture about principles of walkable neighborhoods included these concepts: parks and daily services should be within a five minute walk of most residents; provide a diversity of shops and services; provide housing for a diversity of people; enough people (density) to support the businesses; well-connected streets with sidewalks. Participants worked in groups of four to five to design a walkable neighborhood center, and the groups were left on their own to devise a working process – they were not led by a facilitator.

Table 3. Schedule of the workshops.

Workshop agenda	*Time allowed (minutes)*
1. Arrival, role assigned	10
2. Entry survey	10
3. Introductory lecture	5
4. Instruction on design task and tools	2
5. Work on design task	20
6. Targets provided by researchers	3
7. Continue to work on design task	25
8. Break	20
9. Post-task questionnaire	15
10. Focus group discussion	30
TOTAL	140

Data analysis: All work sessions and all focus groups were video and audio recorded. To evaluate collaboration, we coded from the videos 10 minutes immediately after the groups initiated working and 10 minutes after the groups were given the targets. This was a subjective video analysis in which a researcher recorded time spent on various individual or collaborative tasks, such as studying the building pieces (individual), placing building pieces on the workspace (individual or group), moving them around and discussing the pros and cons of these design moves (collaborative). Every session ended with a focus group discussion, therefore there were eight such sessions with four to five participants in each session. A consistent set of questions was asked at each session. Transcripts of each session were created, coded and summarized by question and answers. Quotes were taken from the transcripts of the focus group discussions. Because the total number of participants is low, actual numbers of the entrance and exit survey responses are presented here. Design performance metrics are built into the UD Co-Spaces system and some were replicated using spreadsheets in the paper workspace. Those metrics are reported here.

4 FINDINGS

Preliminary findings indicate that both the paper and digital tools were easy to use, engaging, and enabled collaboration, discourse about implications of urban design decisions, and both self- and peer-learning. Working processes varied as explained below. Resulting design solutions had some differences: all of the digital groups met the minimum targets for a walkable neighborhood and some exceeded the targets; all but one paper group met the minimum targets. All digital groups and all except one paper group improved their designs relative to neighborhood walkability after learning of the walkability targets. However as discussed below, it was difficult to conclusively establish significant differences between the experiences and learning of the two different groups.

4.1 Design performance:

As stated above, all groups were presented with principles of walkable neighbourhods at the start of the workshop. Every team prepared a credible solution by adding both commercial spaces and new dwellings to the site (Figure 2). Throughout their working process, all groups discussed the types of housing and the density of the different housing types and considered where to put higher density housing relative to commercial areas and the existing dwellings adjacent to the site. All groups considered where commercial spaces should be located relative to the streets and the residential areas. Most groups spent considerable time discussing if and where public open space should be located relative to housing, commercial spaces and roadways. At the 20-minute mark two targets (to add a minimum of 5000 square meters of commercial space, and to add a minimum of 250 new residents) were introduced. In addition, the digital groups, who had available visualizations of a metric for percentage of walking trips, were advised that they should exceed 25% walking trips (existing condition was 5%). Prior to receiving the targets, only two of eight groups had met the targets for commercial space, while four of eight had met the targets for population (Figure 3). After learning about the targets, seven of eight groups improved their metrics of walkablility, whereas one team, who had initially met the targets, did not meet them with their final solution. Two digital groups exceeded one target by a significant measure. Most of the paper groups worked to just meet the targets, excepting the one group who went backwards on commercial space and in the end did not meet the commercial target.

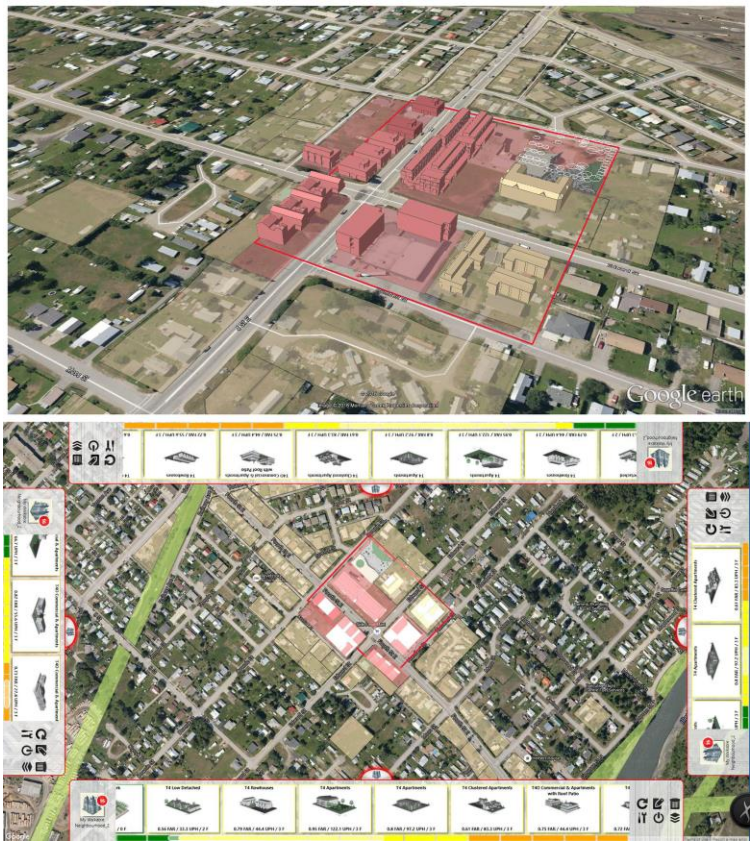

Figure 2: Digital design solution. Screenshots of one group's solution in the digital workspace. Top: 3D view projected on a wall; Bottom: 2D view shown on the tabletop. Images by the authors.

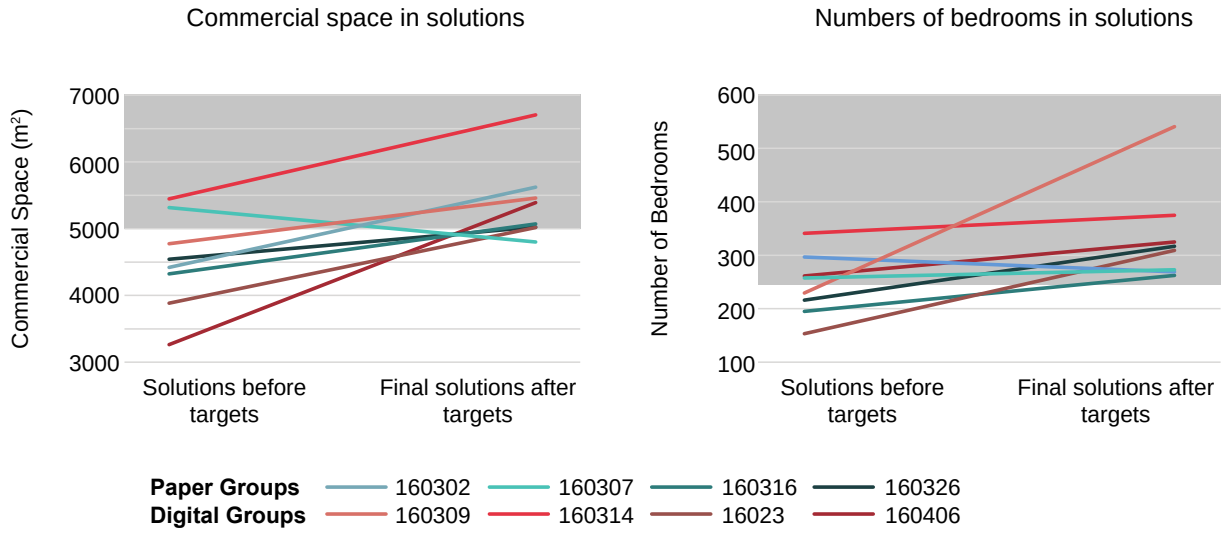

Figure 3: Groups' design solutions measured against commercial space and population. Left: metrics for commercial space before and after learning the targets. Right: metrics for numbers of bedrooms (proxy for population) before and after learning the targets. The grey areas are at or above the targets. Image by the authors.

4.2 Engagement:

In exit surveys 92% of respondents found the exercise engaging or very engaging. One person was neutral and two found it somewhat engaging. Nine people (of all participants) qualified their comments about being engaged by saying they did not have enough “back story” about the neighborhood (demographics, infrastructure information; more photos) and as such they questioned the realism of the exercise. In the focus groups they elaborated with comments such as: the visual aspects were very engaging (digital group); liked the cards with two views and metrics on them (paper); liked having people play different roles; more engaged after the targets were given. Digital groups also stated that they found the real-time synced displays to be engaging, however, when asked which display they found most helpful, they were evenly split about the 2D table workspace, the 3D visualization, and the metrics on the iPads. Digital group participants mentioned some issues with the technology were problematic (scaling of some 2D pieces; no indication of case data once placed in design; inability to undo an action) and a small number felt the touch-table workspace was challenging to learn.

4.3 Collaboration:

It is important to clarify that only one shared workspace was provided in each of the paper and the digital environments. Groups were therefore required to collaborate to some extent on a single solution. When asked if they felt that they worked collaboratively, 89% of survey respondents to the exit survey agreed or strongly agreed that their group worked collaboratively. In the focus groups sessions, groups commented that everyone contributed to the solution; different roles helped them to collaborate; they collaborated more after they got the targets.

Analysis of video revealed differences between the amount and timing of individual vs. collaborative activity and the nature of discourse between the paper-based and the digital groups (Figure 4). In every session, there were periods of time when individuals worked alone, studying the map, the cases, or the metrics and sometimes smaller groups worked together or discussed. In all instances, they returned to whole group for discussion and decision-making. The paper groups worked at a table around the map, thus they were sitting very close together. In every instance, the paper groups started out by individually studying the workspace and paper pieces as well as the wall projection, which summarized all of the “cases” information. Similarly, the digital groups also started by studying the “case bar” and opening up cases to study their information. However, they more often discussed and helped each other to figure out how to use the tools (i.e. read the cases information, drag, rotate, expand, delete cases on the table; rotate the 3D view; add or subtract metrics on the iPads).

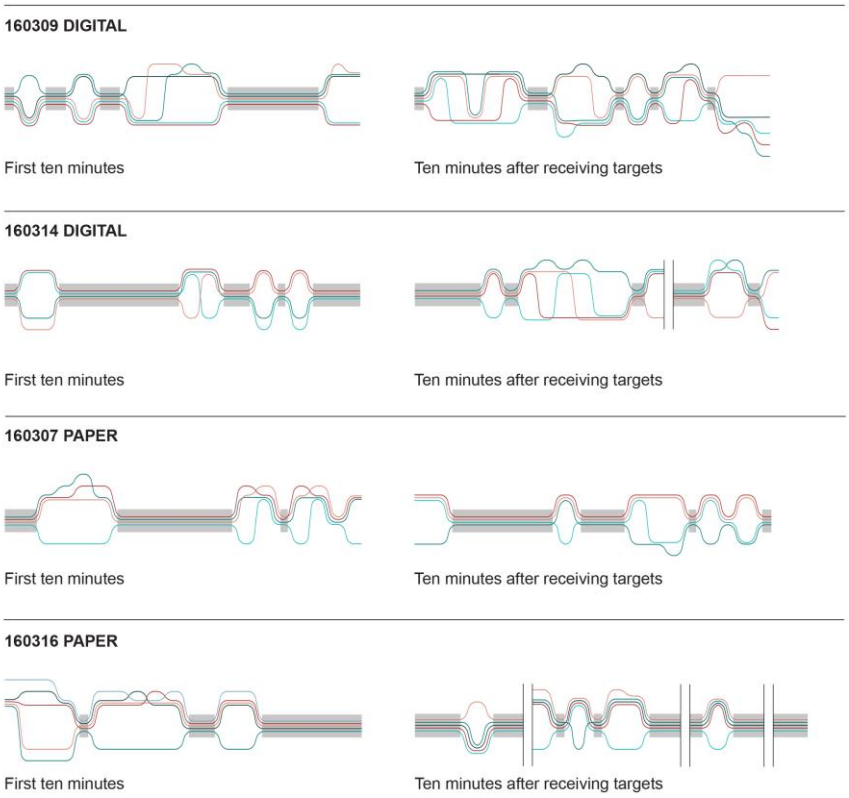

Figure 4. Video analysis of four groups working process covering the first ten minutes of working (left) and the ten minutes after receiving the targets (right). Each colored line represents an individual. The grey bars indicate full group collaborative work. The method was a subjective video analysis. Image by the authors.

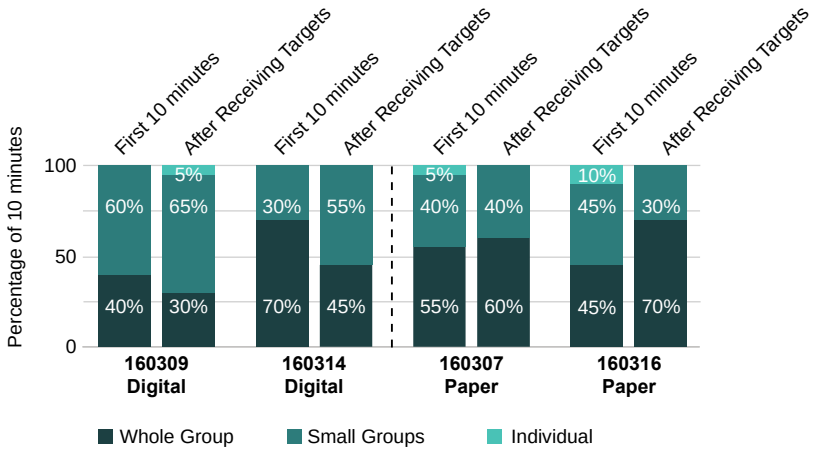

Figure 5. Summary of groups working processes. Percentage of time working as a whole group, in smaller groups or individually, covering the first ten minutes of working and the first ten minutes after receiving the targets. Image by the authors.

Video analysis of two ten-minute segments for each of four groups (two paper and two digital) indicates that the two paper groups spent more total time working together as a whole group of four (or five) and for longer periods of time than did the two digital groups (Figures 4 and 5). The digital groups worked individually or in smaller groups and came back together as a whole group more frequently, but for shorter periods of time. Overall, paper groups spent, on average, 58% of their time working together as a whole group whereas the digital groups spent 46% of their time working that way. Both digital groups spent less time working together as a whole group after receiving the targets, however, both paper groups increased their time working together after receiving the targets. Video analysis indicates that individuals in the digital groups broke from the whole group to study case information, the metrics on the iPads or to rotate and study the 3D view, then returned to the whole group with commentary or suggestions informed by their side studies. The paper groups had only the paper pieces to work with, thus as they became more familiar with the pieces, they spent less time individually studying them and more time working together on their design solution.

4.4 Information and visualization:

In the focus groups discussions, people in three of four focus groups (paper) felt the paper pieces were helpful but some were put off by having to flip them over to see a different view. They were able to see either a 2D or a 3D view, not both concurrently. Some people liked the limited choices of cases, others wanted more choices, and one person wanted to be able to modify them. One group discussed the potential merits of real 3D blocks instead of paper pieces. All four groups mentioned the value of having targets to work toward. Individuals in one paper group suggested that it would be better to be able to control the metrics calculations themselves (these were calculated by a researcher). One person specifically requested metrics on an iPad (although he or she had not seen our iPads in operation). In the digital groups, two of four groups mentioned that they found the syncing of the three screens (2D tabletop, 3D visualization and metrics on iPads) to be very instructive. They specifically mentioned that the metrics on the iPads helped them to understand the impacts of the design solutions. When asked in the exit survey, which interface or screen was most helpful (2D tabletop, the iPads with metrics; 3D visualization) 68% said the touch table work surface was most helpful, followed by 22% finding the iPads with metrics to be most helpful (the balance found the 3D view most helpful). However, this is contradicted by responses in the focus groups where six of fifteen said they found all three tools together to be most helpful, with five finding the 3D view and four finding the iPads as most helpful. Finally, all groups reported in the focus groups that collaboration increased after targets were introduced, however, some felt their groups became too goal oriented.

4.5 Discourse:

The discourse between group members during the working process was very relevant to how to make neighborhoods more walkable while remaining sensitive to the values of the group members (in their roles) and to the existing neighborhood context. People regularly referenced the visual information and data during their discussions. There were common topics of discussion across all groups, including: neighborhood character, particularly building style and heights; how increased density (and some building types) will impact the existing neighborhood; how increased density will improve walkability and transit service; the role and influence of adding commercial space (a proxy for commercial services) in improving walkability; the importance of having greenspace or parks and where they should be located; safety issues relative to vehicles on roads and in parking areas. While not entirely absent, economic aspects of new development were rarely discussed (and no data was provided about this topic).

4.6 Learning:

When asked in the exit survey if their knowledge of how the design of a neighborhood affects walkability had changed as a result of the experience, 51% agreed or strongly agreed, 27% answered “neutral” and 22% disagreed or strongly disagreed. As mentioned above, 35% of the participants were graduate students in planning, landscape architecture or architecture where they had previously learned about factors that encourage or inhibit walkability, and several of these students commented that they had not learned anything new. In an open-ended question about what they learned numerous individuals listed that they learned about how to make neighborhoods more walkable, specifically: population and commercial requirements must be closely met; walkability strategies; zoning for commercial space versus straightway residential space; density is critical for business to be sustained; the effects on use of space and walkability

in the context of urban density; what is needed to make something walkable; better understanding the walkability concept; complexity of the neighborhood as an overall system. One participant elaborated, "I learned about the effects on use of space and walkability in the context of urban density. It has been great to see the effects of urban development in terms of transportation, walkability, environmental impact, etc."

Numerous others commented that they learned about the public engagement process, specifically: learned more about collaborative strategies than about non-interpersonal elements of planning; learned a little about compromising objectives and being convinced by others; people from different majors have different perspectives; taking all stakeholder views into account and coming up with a compromise so everyone is happy was new to me; different things matter to different people; difficulties of balancing various group desires with the project targets. A planning student stated that the workshop was valuable for "giving me some insight into the potential conflicts and challenges of participatory design processes."

5 DISCUSSION

Sanoff (2008, p. 62) stated, "Planning for participation requires that participation methods be matched to the objectives, and the appropriate method be selected. The professional's role is to facilitate the community's ability to reach decisions about aspects of their environment through an easily understood process." Al-Kodmany (2001) added that digital systems may not be suited to all types or stages of public engagement and may not be the best tool to meaningfully engage the public. He had earlier concluded that digital technology and information have potential to marginalize some people because digital systems can seem too foreign or complex for people who are not digitally comfortable (Al-Kodmany, 2000). This was somewhat corroborated by this study. In terms of being surrogates for stakeholders in real community engagement processes, today's students are digital natives and are very comfortable with touch screens and synced visualizations. As well, roughly a third of the participants were knowledgeable about walkable communities. In the focus group sessions, several students wondered if senior citizens or non-tech-savvy people might feel alienated by the digital system, and one of our participants, a 48-year old non-student, did not engage the table and had difficulty orienting to the 3D view. The system had been tested previously on both professional audiences and the public in community engagement processes (Mahyar, 2016; Girling, 2016). These studies similarly found that the workshop format and the multi-display system "enables dialogue and learning about others' perspectives, improves understanding, and increases comfort levels," as well as increased understandings of complex planning problems (Girling, 2016, p. 155). However, similar questions remained about how the visualizations affected different people's overall acceptance of more sustainable development solutions (Girling 2016). The demographic limitations of digital tools such as these clearly merit further study and different research methods should be employed to answer questions such as these in real public engagement processes with lay participants.

The workshop method of public engagement tested here has limitations of size or numbers of people who can be reached. In both cases a "table" of people was ideally four to six, thus for many municipally driven processes, many sessions with numerous tables of people would be needed to reach a significant number of people. These workspaces also have limitations of geographic scale. They are more suited to public engagement around issues of neighborhood scale urban design as opposed to consideration of broad policy topics or large geographic extents. While iPads and similar small touch screen devices are ubiquitous, larger-scale touch tables are not yet in widespread use. Few municipalities have access to this technology at present and although several similar systems are being tested in academic environments, at present there are no commercial systems available that are comparable to UD Co-Spaces (Mahyar, 2016; Ben Joseph, 2001).

Although both paper-based groups and digital groups reported that they worked collaboratively, we found through video analysis that the nature of the collaboration differed somewhat. Every group had a unique working process and thus it was difficult to define patterns. However, based on the analysis reported in Figure 4, we found the paper groups were more intimate and conversational in their processes, whereas the digital groups moved in and out of whole group discussions. They worked alone, in small groups and in the whole group somewhat fluidly. Individuals in the digital groups tended to work more with one of the interfaces and some actually took charge of one interface on behalf of the group (working on the table, checking metrics on the iPads, or "driving" the 3D view). We were unable to evaluate which is better or if there is a better process, thus this aspect of small groups working in a multi-display, information-rich environment deserves much more attention.

Kolb's theory of experiential learning was at least in part substantiated. Students reported self-learning via the exercise and we observed some peer learning. Most importantly, students reported that they learned about other people's viewpoints – that they do differ and that they have valid points to make, and half of the students learned something new about how urban design impacts walkability. Both workspaces enabled an iterative design process in which groups experimented with ideas, then evaluated them against metrics and through critical discourse. Ninety-seven percent of the participants agreed that creating different alternatives helped them to make a better final design. Like Gordon (2011), we found that engaging and immersive media can provide meaning to participants and result in peer learning and buy-in. In this exercise, we were expecting to find that the digital environment would be more engaging than the paper environment and that we would therefore see some evidence of greater engagement and or greater learning. We do not have enough evidence to back up this hypothesis. In fact, our evidence somewhat contradicts this – 17 of 18 individuals in the paper groups and 17 of 19 individuals, in the digital groups found the exercise was engaging or very engaging.

Integrating data and visualizations of information enabled high-level, informed and focused discourse about neighborhood walkability. In this study, we made the two workspaces as similar as possible, however, the digital workspace had far more information available on demand by the users and they could control both the selection of metrics they could view and the 3D view. The paper groups had 3D views of individual cases but they were restricted to a 2D map view of their solutions. We expected to find greater differences between the working processes, nature of discourse, and resulting solutions between the paper and digital groups. As stated, the digital groups had access to real 3D visualizations, far more information about the individual cases and more metrics by which to evaluate their solutions. However, exactly how this information impacted working processes, learning and satisfaction with results was difficult to uncover in this particular study.

Multi-display design decision support tools such as the one tested here can contribute rich information in understandable formats to public engagement workshops. The synced and live-updated displays were valued by participants and enabled informed discourse, collaboration and self and peer learning. The system tested here was considered to be very user-friendly and fast to learn for most participants, thus it was not an impediment to the work process. In fact, it engendered a somewhat different working process than the paper workspace. The single collaboration workspace, clearly defined work task, evidence-based feedback and tactile nature of both workspaces contributed to active engagement and collaboration. Both workspaces were rated as engaging by participants, which may suggest that both paper and digital engagement tools, which include multiple-channel visualizations and feedback information, and are centered on co-design, have a valuable place in public engagement workshops.

6 REFERENCES

Al-Kodmany, K. (2000). Public participation: Technology and democracy. *Journal of Architectural Education,* 53(4), 220-228.

Al-Kodmany, K. (2001). Visualization tools and methods for participatory planning and design. *Journal of Urban Technology*, 8(2), 1-37.

American Planning Association (2006). *Planning and Urban Design Standards.* Hoboken, N.J.: John Wiley and Sons, 543.

Arciniegas, G., Janssen, R. (2012). Spatial decision support for collaborative land use planning workshops. *Landscape and Urban Planning* 107, 332–342.

Ben-Joseph, E., Ishii H., Underkoffler J., Piper B., Yeung L. (2001). Urban simulation and the luminous planning table: Bridging the gap between the digital and the tangible. *Journal of Planning Education and Research* 21(2), 196-203.

Bond, S., Thompson-Fawcett, M. (2007). Public Participation and New Urbanism: A Conflicting Agenda?, *Planning Theory and Practice*, 8(4), 449-472.

Brody, S. D., Godschalk, D. R., Burby, R. J. (2003). Mandating citizen participation in plan making: Six strategic planning choices, American Planning Association. *Journal of the American Planning Association*, 69(3), 245.

Cross, N., (Ed.). (1972). Design participation: proceedings of the Design Research Society's conference, Manchester, September, 1971. London: Academy Editions.

Daniels, S. E., Walker, G. B. (1996). Collaborative Learning: Improving public deliberation in ecosystem-based management. *Environmental Impact Assessment Review*, 16, (2).

Davis, J. (2008). Engaging and Informing Citizens with Household Indicators. *Proceedings of the 41st Hawaii International Conference on System Sciences*.

Girling, C., Kellett, R. (2000). Visualization and Decision Support Tools for Community Planning. *Research and Architecture Les Cahiers de l'enseignement de l'architecture* European Association for Architectural Education, Paris, 2000, No.9, 259-268.

Girling, C., Kellett, R. Johnstone, S. (2006). Informing Design for Participation in Neighborhood-Scale Planning. *Integrated Assessment*, 6(4).

Girling, C., Senbel, M., Kellett, R. (2017). Effects of visualizations and information rich public engagement in planning for energy and emissions. *Journal of Architectural and Planning Research*, 33(2), 140-158.

Gordon, E., Schirra S., Hollander J. (2011). Immersive planning: a conceptual model for designing public participation with new technologies. *Environment and Planning B: Planning and Design* 38, 505-519.

Grant, J. (2006). *Planning the good community: new urbanism in theory and practice*. London; New York: Routledge.

Hanna, K. S. (2000). The paradox of participation and the hidden role of information: A case study. *Journal of the American Planning Association,* 66(4), 398.

Healey, P. (1997). *Collaborative Planning: shaping places in fragmented societies*. Houndmills, Basingstoke: Macmillan Press.

Holden, M. (2008). Social learning in planning: Seattle's sustainable development codebooks. *Progress in Planning* 69, 1–40.

Hollander, J. B. (2012). Intelligent participation: engaging citizens through a framework of multiple intelligences. *Community Development*, 43(3), 346-360.

Innes, J. E. (1998). Information in communicative planning. *Journal of the American Planning Association*, 64(1), 52-63.

Innes, J. E., Booher, D. E. (2004). Reframing public participation: strategies for the 21st century. *Planning Theory & Practice*, 5(4), 419-436.

Kaliski, J. (2006). Democracy Takes Command: The new community planning and the challenge to urban design. In Saunders, W. S., *Urban Planning Today*. Minneapolis: University of Minnesota Press.

King, S. (1983). *Co-Design: A Process of Design Participation*. Van Nostrand Reinhold, New York, USA.

Kolb, D.A. (1984). *Experiential Learning: Experience as the source of learning and development*. Engelwood Cliffs, N.J.: Prentice Hall.

Kwartler, M., Longo, G. (2008) *Visioning and Visualization: People, pixels and plans*. Cambridge, MA: Lincoln Institute of Land Policy.

Lennertz, B., Lutzenhiser, A. (2006). *The charrette handbook. The essential guide for accelerated collaborative community planning*. Chicago: The American Planning Association.

Mahyar, N., Burke, K. J., Xiang J., Ming, S., Booth, K. S., Girling, C. L., Kellett, R. W. (2016). UD Co-Space: A Table-Centerd Multi-Display Environment for Public Engagement in Urban Design Charrettes. In Proceedings of the ACM International Conference on Interactive Surfaces and Spaces (ISS '16), ACM, New York, NY, USA.

National Charrette Institute (2004). NCI Cross-disciplinary Public Involvement Report, National Charrette Institute. Retrieved January 8, 2017 from http://charretteinstitute.org/wp-content/uploads/2016/07/NCI-RWJF_Report.pdf

Moser, S. (2010). Communicating climate change: history, challenges, process and future directions. *Climate Change* 1(1), 31-53.

Rocha, E. (1997). A ladder of empowerment. *Journal of Planning Education and Research* 17(1), 31-44.

Roggema, R., (Ed.) (2014) *The Design Charrette: Ways to envision sustainable futures*. Dordrecht: Springer.

Salter, J. D., Campbell, C., Journeay, M., Sheppard, S. R. J. (2009). The digital workshop: Exploring the use of interactive and immersive visualization tools in participatory planning. *Journal of environmental management,* 90(6), 2090-2101.

Sanders, E. B. N., Stoppers, P. J. (2008). Co-creation and the new landscapes of design. Codesign, 4(1), 5-18.

Sanoff, H. (2000). *Community Participation Methods in Design and Planning.* New York: John Wiley & Sons.

Sanoff, H. (2008) Multiple Views of Participatory Design. Archnet-IJAR, *International Journal of Architectural Research*, 2(1), 57-69.

Sheppard S. (2012). *Visualizing Climate Change: A guide to visual communication of climate change and developing local solutions* London: Routledge.

Senbel, M., Church, S. P. (2011). Design Empowerment: The Limits of Accessible Visualization Media in Neighborhood Densification, *Journal of Planning Education and Research* 31, 423.

Sorkin, M., (2006). Will new plans for the gulf drown it again, this time in nostalgia? *Architectural Record*, 94(2), 47-52.

Snyder, K. (2003). Tools for community design and decision-making. In Geertman, S., Stillwell, J. (Eds.) *Planning Support Systems in Practice*, New York: Springer, 99–120.

Talen, E. (2011). The Geospatial Dimension in Urban Design. *Journal of Urban Design*, 16(1), 127 -149.

Van der Laan, M., Kellet, R., Girling, C., Senbel, M., Booth, K., Su, T. (2013). A Collaborative Multi-touch, Multi-Display, Urban Futures Tool. Proceedings, 2013 Simulation for Architecture and Urban Design (SimAUD) Symposium, April 7-10, San Diego, CA.

Wheeler, Stephen (2013) *Planning for sustainability: creating livable, equitable and ecological communities*, New York: Routledge.